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Commentary: Manipulating practice variables to maximize learning

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In the last few decades there have been considerable advances in knowledge and technologies in the medical domain. These advances include the development of high-fidelity simulators that serve to enhance the possibilities for medical educators, as well as potentially expediting trainee development. Therefore, there is a requirement for a more structured, systematic and empirically informed approach to medical education in general, especially in order to maximize the potential of these simulation technologies (1). Identifying the critical characteristics that are associated with expert performance enables practitioners to develop training interventions that can be designed and implemented to enhance the specific skills and necessary adaptations that are key to expertise in medicine. Subsequently, this will improve the quality of patient treatment and reduce the costs associated with healthcare training (2). However, how we structure these practice activities in order to ensure long-term learning is still subject to debate.

In the current issue of *Medical Education, XXXXX et al., (3)* discuss how *elaboration theory* may provide a basis for more appropriate, expertise-specific training structure that can expedite skill development. Elaboration theory posits that training should begin with a simplified version of the task, before progressing to more complex versions as the simple tasks have been mastered (4). These ideas share similarities to research from the motor skills literature, namely, the *challenge point framework* (5). The principal idea is that "tasks represent different challenges for performers of different abilities" (5, p212). The long-term learning from a given task difficulty will vary based on the: task environment; task complexity; and skill level of the performer. Crucially, although increases in task difficulty may increase the potential learning it may also decrease performance. Therefore, an optimal challenge point occurs when there is maximization of learning and any performance detriments in practice are minimized (6). This provides challenges in how to differentiate the performance and learning of a task.

With regards to elaboration theory, there are certain considerations around the complexity of the initial tasks and what information has been removed in order to simplify the task. Indeed, the removal or delay of certain information has been shown to significantly decrease diagnosis accuracy in emergency medicine scenarios (7). Furthermore, there is evidence that practicing simple tasks does not develop the same memory structures, attentional adaptations and fundamental knowledge-base as practicing the fully complex task with real-world contextual information and emotions (2). It is also critical that there is a simultaneous development of procedural skills and conceptual knowledge, rather than an over-reliance on isolated education, which may occur if a task is overly simplified. Other practice related factors are also important to consider, such as practice schedule, feedback and instruction, all of which can significantly influence the practice performance and long-term learning of a task (8).

Many medical education curriculums promote students to engage in as much practice and procedures as possible to hone skills and develop knowledge. Although it is generally accepted that achieving proficiency in a domain involves the accumulation of experiences and hours, merely undertaking a large number of procedures does not guarantee that expertise will be realized if other variables are limited; such as reflection, feedback and learning (9). However, expert performance has been linked to how much domain-specific deliberate practice has been accrued during an individual's career. Deliberate practice is structured activity which has the principal goal of improving an essential component of current performance (10).

Deliberate practice requires full attention, complete concentration, and maximal effort. Immediate access to useful feedback and the chance to repeat performance is also important, as well as the opportunity for error detection and correction (10). The use of simulated environments for tasks in healthcare training is becoming more prevalent, and provides an opportunity to increase the exposure of healthcare professionals to deliberate practice activities, while limiting the risks to patients and providers. These activities can also benefit from a structured development of challenge point via the elaboration theory paradigm.

XXXXX et al., (3), also use a Delphi method approach to generate a hierarchy of procedures increasing in complexity in order to develop practice environments in line with elaboration theory. Using these expert panels to determine procedure complexity is useful, but there are several limitations based on the individual experiences of the panel and also the prevalence of certain cases in a given area (cultural and geographical differences). Another method of determining case complexity would be to use quantitative data on success rates of procedures, or look to highlight procedures that are most likely to lead to patient complications. Another potential method is to develop a range of high-fidelity simulation assessments with varying case complexities and contextual information and measure known performance metrics and process-tracing measures in experts. These cases can then be systematically ranked based on ease of performance (11). This method provides a more stringent and sensitive measure of case complexity and also highlights the process used by experts (1).

From the discussion above it is apparent that there are several variables that underpin the development of expertise and influence the time it takes to achieve expertise in the medical domain. A robust finding from many fields is that engagement in deliberate practice activities encourages the accumulation of domain-specific procedural and declarative knowledge needed to achieve expertise. Furthermore, the integration of elaboration theory principles appears to be a complementary strategy to efficiently develop expertise, as long as key variables are controlled. The advances in medical simulator technologies enable medical trainees a unique opportunity to amass hours of deliberate practice in representative and controlled scenarios under expert supervision, whilst minimising the risk to patient safety. Medical educators should look to embrace these new technologies to cultivate more interactive and representative learning environments, but also develop systematic and empirically based curriculums.

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